AMENDMENT TO SPECIFICATION - PER 37 CFR 1.121

SPECIFICATION

At Page 2, first paragraph:

The present application is a continuation in part application based upon an original application Serial No. 09/323,215, filed June 1, 1999, entitled: IMPROVED APPARATUS AND METHOD FOR THE REMEDIATION OF PARTICULATE MATERIAL AND TOXIC POLLUTANTS TRANSPORTED IN FLUE GAS that was cancelled in accordance with 35 U.S.C. 120 with the filing of the subject CIP application that the present CIP application depends from.

At page 2, third paragraph:

In the combustion of fossil fuels, as for power generation, a variety of particulate matter and gaseous pollutants, some of which are toxic, are produced and discharged as flue gas. Among which are oxides of sulphur, including sulphur dioxide, [SO_2;] SO_2 oxides of nitrogen and volatile organic compounds. The oxides of sulphur, particularly sulphur dioxide [$SO_{2,}$] SO_2 are generally considered as the most serious and are toxic pollutants. To remove flue gas pollutants, a number of pollution control systems have been developed that remove fine particulate matter and submicron size particles. Some such systems rely on electrostatically charged sorbent particles to attract and agglomerize with unlike charged particles in the flue gas stream, providing particles of a sufficient size to be removed in a moving fluidized bed, by passage through a bag house, in a centrifuge system, or the like. Examples of several such systems that one of the present inventions is a co-inventor of are found in U. S. Patent's No.'s 5,308,590; 5,312,598; and 5,332,562.

At Page 8 last paragraph that continuous onto Page 9:

Fig 1 shows an artists depiction of a preferred form or embodiment of the invention, as it is presently contemplated in an improved apparatus 10, hereinafter referred to as remediation apparatus 10, for the remediation of toxic flue gas pollutants, and is shown aligned for passing exhaust therefrom to a bag house 11. The exhaust, as the invention is suitable for use with, can be a flue gas flow that originates in a plant, such as a coal fired power plant, shown as boiler 13 in Fig. 2, that passes a flue gas through a line 13a, shown in broken lines, and identified as arrow A, that contains pollutants, such as sulphur dioxide (SO_2). [Which pollutants] <u>Said pollutants</u> are removed by the apparatus of and in a practice of the method of the [invention. show herein] <u>invention shown herein</u> as a best mode. In which practice, pollutant particulates that are compacted with fine sorbent particles in a line section of the apparatus 10, as discussed in detail hereinbelow, that provides for impacting flows that create turbulence and provide for a thorough mixing during passage therethrough, forming an agglomerized mix of particulates are then moisturized for separation out of the flue gas flow in a bag house, centrifuge, fluidized bed, water system, or a like agglomerized particulate removal apparatus, for disposal.

At Page 10, last paragraph that continues through Page 11 to Page 12:

The above set out removal rate constitutes a very significant improvement over operations of all other earlier compacting and electrostatic charging systems. In practice, a counter-current injection of the lime particulates as have been fine ground to from fifty (50) to one hundred fifty (150) mesh and to an even smaller mesh of approximately three hundred fifty (50) mesh, depending upon the agglomorized particulate removal system as is employed. In a practice of the invention lime particulates are injected under pressure in a direction that is counter-current to the flue gas flow.

This injection, as shown in the schematic of Fig. 2, is [;preferably] through an injector 15, that is shown as a straight tube, and is fitted into a system duct or manifold 14, that is shown as an open cylinder. The injector 15, shown as a tube or pipe, is maintained at an angle B, that is to the manifold 14 longitudinal axis. The selected angle is preferably an angle from thirty (30) to sixty (60) degrees that the injector 15 center longitudinal axis makes to the outer surface of the manifold 14, and point back into the flue gas flow, arrow A in Fig. 2. The injector 15 provides a sorbent material flow that is directed into, to impact and thoroughly mixed with the flow of toxic flue gas pollutants, arrow A in Fig. 1. The manifold 14, as shown, is preferably an open cylinder, though another appropriate shape of tube or cylinder can be so used, within the scope of this disclosure. So arranged, the sorbent material, that is preferably the finely ground lime particulates selected from a family that includes hydrated lime, quick lime, limestone, or the like. However, for some applications that are not specifically discussed herein, the selected sorbent material may be a non-lime material such as a phosphorus mixture, carbon compound, a compound containing ammonia, or the like, within the scope of this disclosure. In practice, the selected sorbent material is injected, under a pressure of from six (6) to ten (10) psi, as a counter-current flow into the flue gas flow, shown as arrow A. The selected sorbent materials are fine ground to, preferably, a size range of from fifty (50) to one hundred fifty (150) mesh. Though, for some applications, a preferred size of sorbent particles may be larger or smaller within the scope of this disclosure. A flow of sorbent materials, as shown in Figs. 1 and 2, is gravity fed out from a bin or hopper 16 to pass into a feeder 17 that receives pressurized air flow that is passed thereto through a line 19 from a pump 18, as shown in Fig. 2. Shown in Fig. 2, the pressurized air flow with the entrained sorbent material particles is then

passed, shown as arrow C, through feed line 20 and into and through the injector 15 feed tube. This flow, arrow C, is pressurized appropriately to take into account the pressure of the flue gas flow so as to create turbulence in opposing flows, so as to tumble and thoroughly mix the sorbent material particles into, to compact and agglomorize with, the flue gas toxic pollutant particles, in particular sulfur dioxide (SO_2). Which sorbent material pressurization is selected so as not to over-power that flue gas flow, with the combined flows than continuing, shown as arrow D, through the manifold 14. So arranged, the toxic pollutant and sorbent material particulates vigorously are maintained together, tumbling and agglomorizing together along the manifold 14 between the injector 15 end 15b and a moisture injector 25b, as shown in Fig. 2, and as discussed further herein. Which distance D', to provide a thorough and complete mixing, is from twenty (20) to thirty (30) feet between injector end 15b and the moisture injector. Over this distance D', the sorbent material and flue gas particles are thoroughly mixed, the respective particles engaging one another and are compacted and agglomerized together. Optionally, within the scope of this disclosure and for the makeup of a particular flue gas flow, the manifold 14 can include spaced fins 21, shown in broken lines, that are secured along connecting edges of each to project at an angle outwardly from the manifold 14 interior wall. Which project angle for each fin is an angle that is less than ninety (90) degrees to the flue gas flow. The fins 21 are provided, as needed, to further encourage turbulence and a mixing of the particulates in the flow. While the fins 21, for most applications, are not needed, they are included herein as an optional [inclusion..] inclusion.

At Page 13 last paragraph that continues over to Page 14:

The flow of agglomerized sorbent and pollutant particulates travel downstream from the

sorbent injector 15, arrow D, for a traveling distance [D] D' that is from twenty (20) to thirty (30) feet, and passes across a moisture sensor 25 that extends through the manifold 14 wall and into the flue gas flow. The distance [D] D' is the spacing distance between the injector end 15b and the second sensor 25 that measures the moisture content of the mixed flow and, when that moisture content is below eighteen (18) percent humidity, passes a signal through lines 26a and 26b to command operation of pump 27. Pump 27 provides a pressurized water flow from a reservoir [28] 28a, to operate a valve 30 located in line 29 from the water reservoir [28] 28a that opens to direct the flow of water through a nozzle that produces a fine mist that is injected into the flue gas and sorbent material mix flow, arrow E. Which moisture injection is to elevate the moisture content to from eighteen (18) to twenty (20) percent humidity, with the moisturized flow then traveling to a bag house 11, like that shown in Fig. 3, wherein the agglomorized and moisturized particles are removed from the flow, as set out and discussed below.

At Page 14 last paragraph that continues over to Page 15:

In a practice of the invention, where fine sorbent material particles are fed into the flue gas flow, arrow A, in a direction of travel against or counter-current to that flow, intense turbulence is created at the junction of the opposing flows, creating a thorough mixing and over the period of residency to the flow over the distance [D],D' an agglomerization and compaction of the sorbent material particles with pollutant particulates is provided to essentially all the particles that then continue as flue gas flow, arrow D. So arranged, particulate mixing is both thorough and efficient, with at most few un-agglomerized particles found in the flue gas flow, arrow D. This allows for injection of an appropriate volume of sorbent material for the pollutant particles as are actually

present in the flue gas flow, arrow A, thereby reducing the volume of sorbent material as is used to only the volume actually needed to provide for a thorough and complete remediation.

At Page 15, first full paragraph on the page:

The bag house 11, as shown best in Fig. 3, is a preferred precipitate particulate removal facility that, it should be understood, in practice, is a standard unit that includes polyester bags, or bags 36 that are formed to receive the flue gas and agglomorized particulates flows therethrough and are capable of being pulsated to shake collected particles off from the outer surface thereof. Such bag house 11 while preferred for use with the invention, is but one of a number of particulate removal systems as the invention can be used with, to include a centrifuge system, moving bed, water system, or the like, not shown. For such other precipitate removal systems, the optimum humidity or water content of the compacted and humidified flow, arrow [F] <u>E</u>, may vary above or below the preferred moisture content of eighteen (18) to twenty (20) percent that is for use with a bag house 11, as set out above. For example, in a centrifuge particulate removal system, the particulate and water mix can be drier or very wet without a reduction in particulate removal efficience. Such centrifuge particulate removal systems have, in practice, provide for a removal of from seventy (70) to seventy-five (75) percent of the pollutant particulates from a flue gas flow that is exhausted from the centrifuge system, not shown.

Page 15 last paragraph that continues over to Page 16;

When, however, the remediation apparatus 10 of the invention is employed with a standard bag house 11, like that shown in schematic in Fig. 3, the agglomerized particulate removal efficient is greatly increased to where ninety (90) to ninety-seven (97) and greater percent of toxic pollutants,

particularly sulfur dioxide (SO_2) particles are removed from the flue gas flow. This removal efficiency is primarily do the both the long residency time in the manifold 14, across distance [D] D', shown in Fig. 2, that the sorbent and toxic pollutant particles experience along with the close control of the flue gas flow agglomorized particles moisture content, arrow E, that enters the bag house 11. So arranged, a maximum percentage to nearly all of the toxic pollutants, particularly sulfur dioxide (SO2), are removed when the flow moisture content is maintained between eighteen (18) and twenty (20) percent.

Page 16 last paragraph:

As set out above, and the bag house 11preferably utilizes polyester bags 36 that are, in fact, the least expensive bags as are used in conventional bag houses and are most effective when used with the remediation apparatus 10 of the invention for agglomorized particulate removal. This is apparently because the preferred polyester bags 36 are somewhat porous and, with the flue gas flow at the preferred moisture content, a particulate coating is formed on the bag exterior by the entering moist particulates, shown at 28. This particulate coating somewhat fills the bag pores or openings while still allowing for a passage of the gas flow, arrow [F] E. So arranged, nearly all the compacted particulates are captured on the bag surface, with the cleaned flue gas then passed out of the bag necks 37, shown also in Fig. 1, and is vented through a bag house housing vent stack 38, arrow F. Such venting is further encouraged by operation of a vent fan 39 that is turned in that vent stack 38 to pull the now cleaned flue gas flow, arrow F, therethrough. In practice, nearly all the compacted particulates, shown at 41, are removed from the flue gas flow. Thereafter, the compacted agglomorized particulates 41 can be removed, falling off the bag 36 outer surface, when the bag is

oscillated and under the urging of gravity. Which removed particulates 41 fall to the bottom of the bag house housing 35 and pass out of a housing lower vent 40, shown as a flow arrow G, to fall into a catchment vessel 42. The collected compacted particles 41 can then be disposed of.

Page 17 first paragraph:

In a practice of the method of the invention to remove toxic particulates, specifically sulphur dioxide (SO_2) from a flue gas flow as is produced by a coal fired power plant, a finely ground lime is preferably used as the sorbent material and is fed at a rate of 2.1 parts per million (PPM) of lime per 1.0 PPM of toxic pollutant sulphur dioxide (SO_2) particulates into the flue gas flow. The finely ground lime, arrow C, is blown through an adapter 15a located in the sorbent inlet line 15, by operation of blower 18. Shown in Fig. 2, the lime flow passes through the nozzle 15b that is located at the end of the sorbent inlet line 15 and enters into the flue gas flow, arrow A, counter-current to that flue gas flow. The nozzle 15b distributes the finely ground lime flow throughout the flue gas flow, arrow A, that continues through manifold 14, shown as arrow [B] <u>D</u>, providing a residency area across distance [D] <u>D'</u> wherein a thorough mixing and efficient compaction or agglomerization of the sorbent and pollutant particulates occurs. Temperature and moisture content of the flue gas flow, arrow A, can optionally, as needed, be checked at a first or initial sensor 22, that is located in the manifold 14, upstream from the nozzle 15b wherethrough ground lime, under pressure, is passed. The first or initial sensor 22, when present, is connected through line 23a to blower 18, for controlling blower operation to control sorbent transfer, with an addition of water or moisture, when needed, is passed through line 23b by operation of valve 24 that is also connected to first or initial sensor 22. Which sorbent flow and moisture additions are made to the flue gas flow to maintain a

desired pressure and moisture content, and may not, depending upon the flue gas make-up, be required. In which case, the sensing temperature and moisture content of the flue gas, arrow A, is not required and first or initial sensor 22 should thereby be considered to be optional.

At Page 19 first full paragraph:

As set out above, the invention provides a thorough and complete mixing of the injected sorbent materials with toxic pollutant particulates over the distance [D] <u>D'</u>. In addition to the turbulence and mixing provided by the described counter-current injection of the fine sorbent particles into the flue gas flow and the long residency period of turbulence over distance [D, arrow A] <u>D'</u>, further turbulence can be created with an inclusion of fins or baffles 21 in the manifold 14 that are secured at spaced intervals to the inner wall of the manifold, projecting into angled or sloping in the direction os the flue gas flow. The baffles 21, depending upon the efficiency of mixing by the counter-current injection of the sorbent materials into flue gas flow, arrow A, and residency period over distance [D] <u>D'</u>, may not be needed. If, however, such are employed, they are preferably mounted to the manifold 14 inner wall at approximately an angle of from thirty (30) to thirty-seven (37) degrees sloping in the direction of flue gas flow.